CHAPTER-12

DISASTER MANAGEMENT PLAN

12.1 INTRODUCTION

Any Dam project if not designed on the sound principles of design after detail investigations in respect of hydrology, geology, seismicity etc., could spell a large scale calamity. Thus these are inherent risk to the project like improper investigation, planning, designing and construction which ultimately lead to human catastrophy. Though through detailed field investigations it has been ensured that the dam is founded on firm foundation, designed for suitable seismic design parameters, yet in view of that uncertain element of "Force Mejure" the eventuality of a disaster cannot be ignored but a rescue plan has to be devised for confronting such an exigency without being caught in the vast realm of unpreparedness.

A disaster is an unwarranted, untoward and emergent situation that culminates into heavy toll of life and property and is a calamity sometimes caused by "force mejure" and also by human error. The identification of all types of disaster in any proposed project scenario involves the critical review of the project vis-à-vis the study of historical past incidents/disasters in the similar situations. The evolution of disaster management plan dwells on various aspects such as provision of evacuation paths, setting up of alarms and warning systems, establishing communicating system besides delineating an Emergency Response Organization with an Effective Response System. Keeping in view the grievous affects a disaster can cause on human or animal population, loss of property and environment in and around the areas of impact. Therefore it is essential to assess the possibility of such failures in context to the present project and formulate a contingent plan.

12.2 DAM BREAK INUNDATION ANALYSIS

The outflow flood hydrograph from a dam failure is dependent upon many factors such as physical characteristics of the dam, volume of reservoir and the mode of failure. The parameters which control the magnitude of the peak discharge and the shape of outflow hydrograph include: the breach dimensions, the manner and length of time for the breach to develop, the depth and volume of water stored in the reservoir, and the inflow to the reservoir at the time of failure. The shape and size of the breach and the elapsed time of development of the breach are in turn dependent upon the geometry of the dam, construction materials and the causal agent for failure.

For reasons of simplicity, generally, wide applicability and the uncertainty in the actual mechanism, the HEC-RAS model has been used. The model uses failure time interval, terminal size and shape of the breach as the inputs. The possible shapes of the breach that can be accomplished by the model are rectangular, triangular and trapezoidal. The model is capable of adopting either storage routing or dynamic routing methods for routing floods through reservoirs depending on the nature of flood wave movement in reservoirs at the time failure.

The dynamic routing method based on the complete equations of unsteady flow is the appropriate technique to route the flood hydrograph through the downstream valley. The method is derived from the original equations developed by St. Venant. The model uses St. Venant’s equations for routing dam break floods in channels.

12.3 METHODOLOGY

HEC-RAS 4.1 system contains two one dimensional hydraulic components for: i) steady flow surface profile computations; ii) unsteady flow simulation. The steady/unsteady flow computations are capable of modeling subcritical, supercritical, and mixed flow regime water surface profiles. The basic computational procedure is based on the solution of one dimensional energy equation. Energy losses are evaluated by friction (manning's equation) and contraction/expansion (coefficient multiplied by the velocity head). The momentum equation is utilized in situations where the water surface profile is rapidly varied. The graphics include X-Y plots of the river system schematic, cross-sections, profiles, rating curves, hydrographs and many other hydraulic variables.

Model Stability during unsteady flow simulation

HEC-RAS model uses an implicit finite difference scheme. The common problem of stability in the case of unsteady flow simulation can be overcome by suitable selection of following;

- Computational time step
- Theta weighing factor for numerical solution
- Cross section spacing along the river reach
- Solution iterations
- Solution tolerance
- Weir and spillway factor for numerical solution

Computational time step

Stability and accuracy can be achieved by selecting a computational time step that satisfies the courant condition;

$Cr = Vw\ (\Delta t/\Delta x) \leq 1.0$

Therefore: $\Delta t \leq (\Delta x/\ Vw)$

Where:

Vw= Flood wave speed

V = Average velocity of flow

Δx = Distance between the cross sections

Δt = Computational time step

For most of the rivers the flood wave speed can be calculated as:

$Vw = dQ\ /dA$

Factors for various channel shapes are shown in the table below.

Channel shape Ratio (Vw/V)

Wide rectangular 1.67

Wide parabolic 1.44

Triangular 1.33

Natural channel 1.50

Theta weighing factor for numerical solution

Theta is a weighing factor applied to the finite difference approximations when solving the unsteady flow equations. Theoretically theta can vary from 0.5 to 1.0. Theta of 1.0 provides the most stability, while theta of 0.6 provides the most accuracy.

12.3.1 Reservoir Routing

The storage routing is based on the law of conservation given as:

$I - Q = dS/dt$ ……………………..….. (1)

In which, I is reservoir inflow. Q is the total reservoir outflow which includes the flow spillway, breach, overtopping flow and head independent discharge, and rate of change of reservoir storage volume. Equation (1) can be expressed in finite difference form as :

$(1 + I') \, 2 - (Q + Q')/2 = \Delta S/\Delta t$ -.-----(2)

In which the prime (‘) superscript denotes the values at the time $t - \Delta t$ and the notation approximates the differential. The term ΔS may be expressed as:

$\Delta S = (As + A's)(h - h')/2$ ………………(3)

In which, As is the reservoir surface area coincidental with the elevation (h) and is a function of h. The discharge Q which is to be evaluated from equation (2) is a function of h and this known h is evaluated using Newton-Raphson iteration technique and thus the estimation of discharge corresponding to h.

12.3.2 Dynamic Routing

The hydrologic storage routing technique, expressed by equation (2) implies that the water surface elevation within the reservoir is horizontal. This assumption is quite adequate for gradually occurring breaches with no substantial reservoir inflow hydrographs. However, when the breach is specified to form almost instantaneously so as to produce a negative wave within the reservoir, and/or the reservoir inflow hydrograph is significant enough to produce a positive wave progressing through the reservoir, a routing option which simulates the negative and /or positive wave occurring within the reservoir may be used in DAMBRK model. Such a technique is referred to as dynamic routing. The routing principle is same as dynamic routing in river reaches and it is performed using St. Venant's equation. The movement of the dam break flood wave through the downstream river channel is simulated using the complete unsteady flow equations for one dimensional open channel flow, alternatively known as St. Venant's equations. These equations consist of the continuity equation

$$\frac{\partial Q}{\partial t} + \frac{\partial (A + A0)}{\partial t} = q \text{ ....(4)}$$

and the conservation of momentum equation :

$$\frac{\partial Q}{\partial t} + \frac{\partial (A2/ + A)}{\partial t} + g\,A\left(\frac{\partial h}{\partial t} + Sf + S\,e\right) + Lc = 0 \text{ ......(5)}$$

where,

A = active cross – sectional flow area

A0 = inactive (off-channel storage) cross – sectional area

X = distance the channel

q = lateral inflow or outflow per unit distance along the channel

g = acceleration due to gravity

Q = discharge

H = water surface elevation

Ss = friction slope

Se = expansion – contraction loss slope

Lc = lateral inflow/outflow momentum effect due to assumed flow path of inflow being perpendicular to the main flow.

The friction slope and expansion – contraction loss slope are evaluated by the following equation

$$Sf = \frac{n^3 Q^2}{2.21 A^2 R^{3/4}} \qquad \text{.................................(6)}$$

and,

$$Se = \frac{K\Delta(Q/A)^2}{2g\,\Delta X} \qquad \text{...(7)}$$

where,

n = Manning's roughness coefficient

R = A/B where B is the top width of the active portion of the channel

K = Expansion – contraction coefficient varying from 0.1 to 0.3 for contraction and 0.5 to – 1.0 expansion

$\Delta(Q/A)^2$ = Difference in $(Q/A)^2$ for cross sections at their end of a reach

The non-linear partial differential equations (4) and (5) are represented by a corresponding set of non-linear finite difference algebraic equations and they are solved by the Newton-Raphson method using weighted four point implicit scheme to evaluate Q and h. The initial conditions are given by known steady discharge at the dam, for which steady state non-uniform boundary flow equation are used. The outflow hydrograph from the reservoir is the upstream boundary condition for the channel routing and the model is capable of dealing with fully supercritical flow or fully supercritical flow in the reach or the upstream reach having supercritical flow and downstream reach having subs critical flow. There is a choice of downstream boundary conditions such as internally calculated loop rating curve, user provided single valued rating curve, user provided time dependent water surface elevation, critical depth and dam which may pass flow via spillways, overtopping and/or breaching.

12.3.3 Statement of the problem

The computation of flood wave resulting from a dam breach basically involves two scenarios which can be considered jointly or separately: (1) the outflow hydrograph from the pond (2) the routing of the flood wave downstream from the breached dam along the river valley and the flood plain. If breach outflow is independent of downstream conditions, or if their effect can be neglected, the reservoir outflow hydrograph is referred to as the free outflow hydrograph. In this case, the computation of the flood characteristics is divided into two distinct phases: (a) the determination of outflow hydrograph with or without the routing of the negative wave the reservoir, and (b) the routing of flood wave downstream from the breached dam. In this study the problem of simulating the failure of "Dam" and computing the free outflow hydrograph from the breached section using storage routing technique' with the aim of reproducing the maximum water level marks reached during the passage of flood wave is considered. The information regarding inflow hydrograph into the pond due to the storm at the time of failure, the structural and the hydraulic characteristics details of the dam, the time of failure, the channel cross sections details, the maximum water level marks reached in the reservoir at the time of failure and those observed in the downstream reach of the dam to the passage of flood wave etc. are available for the study.

12.3.4 Availability of Data

The input data required can be categorized into two groups. The first data group pertains to the dam and inflow hydrograph into the reservoir and the second group pertains to the routing of the outflow hydrograph through the downstream valley. These are described in the following paragraphs.

- **First Data Group**

With reference to the data group pertaining to the dam, the information on reservoir elevation-volume relationship, spillway details, elevation of bottom and top of dam, elevation of water surface in the pond at the beginning of analysis and at the time of failure, breach description data are required.

- **Second Data Group**

The second group of data pertaining to the routing of the outflow hydrograph through the downstream valley consists of a description of cross-sections, hydraulic resistance coefficients of the reach, steady state flow in the river at the beginning of the simulation and downstream boundary condition. The cross section is specified by location mileage, and tables of top width and corresponding elevation.

12.3.5 Results

The maximum flow and flood wave arrival time at various distances d/s of the dam is given in Table-12.1.

Table-12.1: Summary of wave profile in the event of Dam Break

Location	Distance[a] downstream from dam (km)	Estimated population[b] (People)	Potential loss of life[c] (People)	Overtopping Failure			Non-Flood failure			Large Controlled Release	
				Maximum depth[d] (m)	Maximum velocity[d] (m/s)	Flood wave arrival time[e] (hh:mm)	Maximum depth[d] (m)	Maximum velocity[d] (m/s)	Flood wave arrival time[e] (hh:mm)	Maximum depth[d] (m)	Maximum velocity[d] (m/s)
Araladinni/ Marimatti R.C	0.9	11,902	574	10.60	4.32	00:10	7.58	3.99	00:15	5.99	1.33
Sitimani	1.4	941	465	10.82	5.19	00:08	8.23	4.59	00:15	6.55	2.78
Manahalli	2.5	1,392	388	12.30	3.36	00:12	9.29	3.33	00:20	7.77	2.23
Chick Sitimani	2.8	4,753	305	7.68	1.10	00:22	5.17	0.90	00:30	3.45	0.38
Yelaguru	3.9	785	122	11.20	3.20	00:16	8.21	2.37	00:25	6.71	1.46
Nagasampagi	5.0	964	204	12.67	2.62	00:22	9.57	2.33	00:35	8.21	1.45
Wadawadagi	6.1	500	117	10.83	1.02	00:28	7.93	1.04	00:40	6.48	0.55
Nagaral	7.4	2,600	359	13.30	3.75	00:28	10.26	2.26	00:40	8.95	1.60
Budihal	7.7	826	142	10.48	2.69	00:32	7.45	2.58	00:45	6.13	1.74
Nainegali	8.7	366	38	9.06	0.70	00:50	6.08	0.74	01:10	4.79	0.40
Masuti	8.9	395	87	13.57	4.46	00:44	10.18	3.68	01:00	9.02	2.58
Balabatti	9.1	1,211	169	16.54	1.85	00:56	13.19	1.40	01:15	12.03	1.05
Unidentified Settlement 1	9.4	593	112	14.93	2.98	00:30	11.73	2.65	00:45	10.48	1.83
Mudavinkopp	10.4	350	30	8.04	0.82	01:00	5.08	0.72	01:20	3.79	0.27
Muddapur	11.5	158	0	-	--	--	--	--	--	--	--
Unidentified Settlement2	11.7	1279	83	10.43	2.25	01:02	7.00	1.24	01:30	5.88	0.85
Chitaginakopp	11.9	629	0	2.04	0.28	03:06	--	--	--	--	--
Hultur	12.0	655	0	2.54	0.17	04:08	--	--	--	--	--
Unidentified Settlemement3	12.8	314	30	12.33	1.90	01:02	8.96	1.35	01:20	7.84	1.02

Location	Distance[a] downstream from dam (km)	Estimated population[b] (People)	Potential loss of life[c] (People)	Overtopping Failure			Non-Flood failure			Large Controlled Release	
				Maximum depth[d] (m)	Maximum velocity[d] (m/s)	Flood wave arrival time[e] (hh:mm)	Maximum depth[d] (m)	Maximum velocity[d] (m/s)	Flood wave arrival time[e] (hh:mm)	Maximum depth[d] (m)	Maximum velocity[d] (m/s)
Kalagi	13.0	913	50	12.95	2.60	01:04	9.44	1.56	01:25	8.39	1.06
Bommanagi	13.9	2192	0	--	--	--	--	--	--	--	--
Unidntified Settlement4	14.1	273	41	14.87	3.79	00:58	11.19	3.04	01:20	10.18	2.28
Mudur	15.1	662	37	13.74	3.31	01:08	10.23	2.62	01:30	9.21	2.03
Chalami	15.5	66	0	6.88	0.43	01:54	3.44	0.28	02:35	2.38	0.12
Chick Myageri	16.2	991	7	13.31	2.95	01:22	9.68	2.12	01:50	8.73	1.59
Tapalkatti	16.3	208	0	3.88	0.12	02:50	0.44	0.06	04:50	--	--
Khandaganur	16.8	259	0	11.29	2.97	01:28	7.52	2.33	02:00	6.58	1.75
Hire Myageri	17.5	656	0	12.09	2.89	01:36	8.33	2.05	02:05	7.39	1.61
Handargall	18.5	298	0	13.02	2.63	01:32	9.22	1.87	02:00	8.29	1.47
Handaragala	18.9	1535	0	2.83	0.75	05:30	--	--	--	--	--
Yarazori	19.4	546	0	3.13	0.16	04:46	--	--	--	--	--
Bisala	19.5	921	0	12.56	1.14	02:20	8.65	0.49	02:55	7.72	0.36
Katagur	19.8	385	0	12.46	2.60	01:52	8.31	2.36	02:30	7.46	1.88
Unidentified Settlement 6	20.3	155	0	11.59	2.10	01:54	7.69	1.39	02:35	6.80	1.06
Unidentified Settlement 5	20.4	130	0	12.74	2.99	02:08	8.72	1.96	02:45	7.82	1.60
Valakaladinni	20.4	337	0	13.52	1.60	02:14	9.63	0.98	02:50	8.70	0.72
Ganjhal	20.7	2890	1	12.98	1.44	04:36	9.06	1.085	06:00	7.56	0.84
Basawanal	21.0	1662	0	--	--	--	--	--	--	--	--
Varagodadinni/ Khajagal/ Kengalkada-	21.2	3734	1	13.00	1.85	03:36	9.06	1.44	04:40	7.73	0.99

Location	Distance[a] downstream from dam (km)	Estimated population[b] (People)	Potential loss of life[c] (People)	Overtopping Failure			Non-Flood failure			Large Controlled Release	
				Maximum depth[d] (m)	Maximum velocity[d] (m/s)	Flood wave arrival time[e] (hh:mm)	Maximum depth[d] (m)	Maximum velocity[d] (m/s)	Flood wave arrival time[e] (hh:mm)	Maximum depth[d] (m)	Maximum velocity[d] (m/s)
patti											
Davoor	21.2	224	0	14.49	2.27	01:46	10 67	1.33	02:20	9.78	1.09
Huvanur/ Nandanoor	21.6	1488	1	1099	1.00	04:20	7. 06	0.79	05:45	5.64	0.57
Hiremalagavi 2	21.9	1791	0	7.98	1.39	05:12	406	0.94	07:05	2.42	0.71
Kamaldinni	22.1	152	0	11.96	3.35	02:04	7.98	2.53	02:40	7.12	2.05
Surallkal	22.1	359	0	1.96	0.13	09:00	--	--	--	--	--
Kunchaganur	22.1	175	0	11.63	3.62	02:14	7.50	3.28	02:55	6.58	2.62
Gangur	22.2	319	0	12.19	1.95	02:00	8.40	1.63	02:35	7.52	1.30
Banoshi	22.3	611	0	10.51	1.07	02:10	6.68	0.79	02:50	5.78	0.50
Kudala Sangama	22.4	4829	1	14.08	4.80	02:22	--	--	--	8.89	3.00
Himemalagavi	22.9	393	0	7.98	0.66	05:28	4.06	0.42	07:25	2.37	0.30
Medinapur	23.0	505	0	4.99	0.41	05:42	1.06	0.09	08:40	--	--
Inam Budhal	23.2	277	0	7.96	1.02	06:54	3.92	0.77	09:35	0.29	0.93
Bisanalkoppa	23.3	824	0	9.99	1.17	04:18	6.06	0.81	05:40	4.69	0.60
Bevinal	23.5	1593	0	1.95	0.62	09:04	--	--	--	--	--
Chikkamagi	23.6	581	0	10.97	1.38	06:22	6.98	1.65	08:35	3.93	1.47
Khairwadgi	23.8	476	0	1.97	0.26	08:30	--	--	--	--	--
Chickmalagavi	24.0	507	0	7.98	0.75	05:14	4.06	0.62	07:10	2.41	0.51
Adihal	24.4	413	0	11.00	1.63	02:50	7.05	1.40	03:40	5.89	0.96
Sangam/ Iddalgi	24.5	1188	0	12.00	1044	03:18	8.06	0.96	04:20	6.76	0.70
Hiremagi	24.6	741	0	6.97	0.53	06:56	3.00	0.50	09:50	--	--
Kamatagl	24.6	4331	0	4.90	0.59	08:52	--	--	--	--	--

Location	Distance[a] downstream from dam (km)	Estimated population[b] (People)	Potential loss of life[c] (People)	Overtopping Failure			Non-Flood failure			Large Controlled Release	
				Maximum depth[d] (m)	Maximum velocity[d] (m/s)	Flood wave arrival time[e] (hh:mm)	Maximum depth[d] (m)	Maximum velocity[d] (m/s)	Flood wave arrival time[e] (hh:mm)	Maximum depth[d] (m)	Maximum velocity[d] (m/s)
Iddalgi2	24.8	96	0	10.99	0.74	03:34	7.06	0.40	04:40	5.75	0.30
Papathanal	25.0	1428	1	10.97	1.29	05:40	7.06	1.06	07:40	5.26	0.80
Tangadgi	25.4	1459	1	10.78	2.13	02:58	6.80	1.20	03:50	5.67	1.04
Kirasur	25.4	258	0	1.98	0.07	08:16	--	--	--	--	--
Gangur II	25.4	749	0	6.97	1.08	06:12	3.05	0.81	08:40	1.11	0.52
Yemmihatti	26.0	250	0	12.57	2.35	02:46	8.56	1.73	03:30	7.42	1.47
Madapur	26.5	178	0	2.97	0.13	07:48	--	--	--	--	--
Ramathal	26.5	419	0	--	--	--	--	--	--	--	--
Kamadatta	26.8	4185	1	8.00	0.30	03:48	4.05	0.25	05:10	2.82	0.19
Dhannur	27.0	748	0	13.40	2.21	02:50	9.48	1.48	03:35	8.32	1.27
Amaragol	28.3	395	0	6.88	1.96	04:10	2.88	0.51	05:50	1.69	0.45
Huvinahalli	28.4	648	0	--	--	--	--	--	--	--	--
Hullalli	28.9	1300	1	7.08	1.96	04:02	3.23	1.12	05:30	2.05	0.92
Hadagall	29.5	290	0	10.71	2.28	03:24	6.85	1.22	04:25	5.63	1.04
Ballkur	30.8	300	0	8.27	3.06	04:00	4.38	1.70	05:15	3.13	1.50
Marola	31.1	2942	1	8.45	0.91	03:56	4.64	0.19	05:10	3.39	0.11
Madari	31.4	1154	0	6.83	1.85	04:30	--	--	--	1.83	0.19
Garasangi	33.6	654	0	--	--	--	--	--	--	--	--
Havargl	34.2	1283	0	3.44	0.69	06:16	--	--	--	--	--
Hunakunti	34.6	663	0	7.87	2.32	04:40	4.38	1.19	06:05	3.11	0.77
Koujaganur	37.3	832	0	3.01	0.17	06:50	--	--	--	--	--
Hanumakatti	37.4	155	0	5.78	2.58	05:22	2.22	1.31	07:27	0.95	0.83
Bangaragund	37.6	1523	0	2.71	0.14	07:06	--	--	--	--	--
Kamaladinnl	38.3	1441	0	5.52	0.63	06:14	2.40	0.68	08:05	1.07	0.86

Location	Distance[a] downstream from dam (km)	Estimated population[b] (People)	Potential loss of life[c] (People)	Overtopping Failure			Non-Flood failure			Large Controlled Release	
				Maximum depth[d] (m)	Maximum velocity[d] (m/s)	Flood wave arrival time[e] (hh:mm)	Maximum depth[d] (m)	Maximum velocity[d] (m/s)	Flood wave arrival time[e] (hh:mm)	Maximum depth[d] (m)	Maximum velocity[d] (m/s)
Vadergonal	38.4	123	0	4.52	0.44	06:26	1.40	0.30	08:35	0.07	0.21
Indawara	38.6	953	0	2.44	0.11	07:22	--	--	--	--	--
Lavalasar	38.7	162	0	2.51	0.19	08:02	--	--	--	--	--
Jalakamaladinni	38.8	323	0	--	--	--	--	--	--	--	--
Rakkasagl	39.4	1570	0	3.12	1.18	06:50	--	--	--	--	--
Manmathanal	39.8	241	0	--	--	--	--	--	--	--	--
Kesarapentl	39.9	782	0	0.52	0.06	01:28	--	--	--	--	--
Islampur	41.2	1965	0	1.47	0.18	08:34	--[f]	--	--	--	--
Dasbal	41.5	208	0	5.52	0.27	05:58	2.40	0.23	07:45	1.08	0.12
Baladinnl	41.5	778	0	7.01	1.61	05:22	3.98	0.94	06:50	2.74	0.57
Pochapur	42.1	344	0	2.52	0.69	07:30	--	--	--	--	--
Karadl	42.5	2196	0	0.52	0.12	11:34	--	--	--	--	--
Ankanhal	43.3	1101	0	5.13	3.45	05:48	2.25	1.40	07:35	1.07	0.88
Karkur	43.5	699	0	5.38	1.33	05:42	2.61	0.21	07:20	1.45	0.11

[a] Approximate shortest distance downstream from dam
[b] Estimated population within the assumed settlement boundaries
[c] Potential loss of life for the overtopping failure scenario base on the estimated population density
[d] Maximum value near the specified location, which usually occurs near the center of the stream
[e] Flood wave arrival time is the time since the initiation of the dam breach until the settlement is inundated
[f] Location not inundated

12.4 EMERGENCY ACTION PLAN

12.4.1 Flood warning system in catchment area

- With the advancement the technology such as satellite and remote sensing, flood waves can be tracked as they move downwards. The linkages will be established with satellites and information will be utilised through remote sensing equipment. The inflow flood forecasting, in the catchment upto Almatti dam, will be an important input data for regulation of outflow flood from Almatti dam. The spillway gate operation schedule for flood management at Almatti and Narayanpur reservoirs is prepared. In the schedule, recommendation for gate operation procedure during normal flows, sequence of opening or closing of gates, methodology regulation at Almatti and summary of flood regulation procedure are given.
- The Central Water Commission maintains close contacts with the administrative and State engineering agencies, local civil authorities to communicate advance warning for appropriate mitigation and preparedness measures. Except flash floods, the timely evacuation can be planned and managed. The flood forecasting would be done a day earlier with respect to the following day. The flood forecasting will be done at 0730 hours and at 15 hours for the following day and it will be intimated to the Executive Engineers of Dam Division, Narayanpur and Almatti and other Officers in charge of the dams. While communicating, the probable flood inflows into Almatti and Narayanpur, are classified into moderate flood, high flood and very high floods. The classification of floods are as follows:

i) Moderate flood - Above 1 lakh cusec (Above 2830 cumec)
ii) High flood - Above 2 lakh cusec (Above 5660 cumec)
iii) Very high flood - Above 3 lakh cusecs (Above 8490 cumec)

12.4.2 Flood warning system due to breach of Narayanpur dam

The flood warning will be put in place as soon as flood forecasting information is received and assuming the breach of Almatti and Narayanpur dams or either any one of them would probably occur. The emergency staff will be alerted to swing into action immediately. Helpline at important places to assist the people and to meet all types of emergencies would be established. One Division headed by Executive Engineer with necessary Sub-divisions is incharge of Almatti dam and also similar arrangement is made for Narayanpur dam. The various Officers of different establishments will be immediately informed once the breach is apprehended. Even during normal flood conditions, there is a practice through which, the people living downstream of the dam will be alerted by various organizations of the Government.

The widely time tested communication to reach every corner of the flood affected zones have been radio and television communication can be sent to key person in each village, who can communicate the same to entire village through Public Address System. These communications will be utilised to broadcast the information will all the languages, regarding the flood situation for the people to move to safer places by themselves, instead of waiting for external help, though external help is also available, Such initiative by the population will render external help more effective and reduce the cost and time. The community involvement is a must. The affected community will be given information about the infrastructure available in their immediate vicinity like high elevated places, shelters, private transport and will be trained as to how to use them once warning is given.

Immediate communication will be sent to District Officers of Revenue, police, Health, Transport, Agriculture and as well as other officers through Wireless, Phone, Mobile, and other modes. In addition to the existing communication systems, additional communication systems ale also proposed. The public will be given information through Radio, T. V. and Cable network systems. The officers in-charge of relief works will also make arrangements to alert people through motor vehicles mounted sound systems to move to safer places. Administration through district, taluk and local self-Government officers will take necessary steps to evacuate the people and monitor relief operations.

The higher locations near each village shall be identified for temporary shifting of the population. The roads and pathways will be constructed for reaching such high elevated places. Village wise requirement of vehicles food materials, health materials have been identified.

12.5 DISASTER MANAGEMENT PLAN

12.5.1 Dam Safety and Maintenance Manual

Based on standard recommended guidelines for the safety inspection of dams a manual should be prepared by the project proponents in respect of dam safety surveillance and monitoring aspects. This should be updated with the availability of instrumentation data and observation data with periodical review. The need for greater vigil has to be emphasized during first reservoir impoundment and first few years of operation. The manual should also delve on the routine maintenance schedule of all hydro-mechanical and electrical instruments. It should be eloquent in respect of quantum of specific construction material needed for emergency repair along with delineation of the suitable locations for its stocking and also identify the much needed machinery and equipment for executing emergency repair work and for accomplishing the evacuation plan.

12.5.2 Emergency Action Plan (EAP)

Dam safety programme as indicated above includes the formation of an Emergency Action Plan for the dam. An emergency is defined as a condition of serious nature which develops unexpectedly and endangers downstream property and human life and required immediate attention. Emergency Action Plan should include all potential indicators of likely failure of the dam, since the primary concern is for timely and reliable identification and evaluation of existing of potential emergency.

This EAP presents warning and notification procedures to follow during the monsoon season in case of failure or potential failure of the dam. The objective is to provide timely warning to nearby residents and alert key personnel responsible for taking action in case of emergency.

12.5.3 Administration and Procedural Aspects

The administrative and procedural aspects of the Emergency Action Plan consist of flow chart depicting the names and addresses of the responsible personnel of project proponent and the Dist. Administration. In order of hierarchy, the following system will usually be appropriate. In the event that the failure is imminent or the failure has occurred or a potential emergency conditions is developing, the observer at the site is required to report it to the Junior Engineer who will report to the Executive Engineer / Superintending Engineer for their reporting to the Chief Engineer through a wireless system or by any available fastest communication system. The Engineer-in-Charge is usually responsible for making cognizant with the developing situation to the Civil Administration. Each personnel are to acknowledge his/her responsibilities under the EAP in an appropriate format at a priority.

The technical aspects of the EAP consist of preventive action to be taken with regards to the structural safety of the dam. The EAP is drawn at a priority for the regular inspection of the dam. For this purpose, providing an adequate and easy access to the dam site is a necessity. The dam, its sluices, overflows and non-overflow sections should be properly illuminated for effective operations during night time. Whenever sinkholes, boils, increased leakages, movement of masonry rock, gate failure, rapid rise or fall of the level in the reservoir, rise in the level of reservoir beyond the maximum working level, or wave overrun of the dam crest are observed, the personnel on patrol is required to inform immediately to the Junior Engineer (JE) / Assistant Engineer (AE) for initiation of the execution of EAP. They are required to inform the Engineer-in-Charge and the local administrative authorities. It is desirable if the downstream inhabitants are warned using siren, if available, so as to make them aware the likely imminent danger.

The other preventive measures may include availability of sufficient number of sandbags at several selected downstream locations and logs (for holding sandbags) and at the dam site, one tractor, two motor boats, gas lanterns, Manila ropes and life jackets. Areas from where the labour can be mobilized should be chalked out at a priority. In addition to these, public participation in the process of execution of the EAP may further help in amelioration of the adverse impacts of the likely disaster. For this, it is necessary that the public should be made aware of its responsibilities.

12.5.4 Preventive Action

Once the likelihood of an emergency situation is suspected, action has to be initiated to prevent a failure. The point at which each situation reaches an emergency status shall be specified and at that stage the vigilance and surveillance shall be upgraded both in respect of time and level. At this stage a thorough inspection of the dam should be carried out to locate any visible sign(s) of distress.

Engineers responsible for preventive action should identify sources of equipment needed for repair, materials, labour and expertise for use during an emergency. The amount and type of material required for emergency repairs should be determined for dam, depending upon its characteristics, design, construction history and past behavior. It is desirable to stockpile suitable construction materials at appropriate sites. The anticipated need of equipment should be evaluated and if these are not available at the dam site, the exact location and availability of these equipments should be determined and specified. The sources/agencies must have necessary instructions for assistance during emergency. Due to the inherent uncertainties about their effectiveness, preventive actions should usually be carried out simultaneously with the appropriate notification on alert situation or a warning situation.

12.5.5 Communication System

An effective communication system and a downstream warning system are absolutely essential for the success of an emergency preparedness plan. The difference between a high flood and dam-break situation must be made clear to the downstream population.

12.5.6 Evacuations Plans

Emergency Action Plan includes evacuation plans and procedures for implementation based on local needs. These could be:

- Demarcation / prioritization of areas to be evacuated.
- Notification procedures and evacuation instructions.
- Safe routes, transport and traffic control.
- Safe areas/shelters.
- Functions and responsibilities of members of evacuation team.

Any precarious situation during floods will be communicated either by an alert situation or by an alert situation followed by a warning situation. An alert situation would indicate that although failure of flooding is not imminent, a more serious situation could occur unless conditions improve. A warning situation would indicate that flooding is imminent as a result of an impending failure of the dam. It would normally include an order for evacuation of delineated inundation areas.

12.5.7 Evacuation Team

It will comprise of following official / Representative:

- District Magistrate (D. M.)/ His Nominated officer (To peacefully relocate the people to places at higher elevation with state administration).
- Engineer in charge of the project (Team Leader)
- Superintendent of Police (S. P.) / Nominated Police Officer (To maintain law and order)
- Chief Medical Officer (C. M. O.), (To tackle morbidity of affected people)
- Head of affected village to execute the resettlement operation with the aid of state machinery and project proponents.
- Sub committees at village level

The Engineer-in-Charge will be responsible for the entire operation including prompt determination of the flood situation time to time. Once the red alert is declared the whole state machinery will come into swing and will start evacuating people in the inundation areas delineated in the inundation maps. For successful execution, annually demo exercise will be done. The D.M. is to monitor the entire operation.

12.5.8 Public Awareness for Disaster Mitigation

In addition, guidelines that have to be followed by the inhabitants of flood prone areas, in the event of flood resulting from dam failure, which form part of public awareness for disaster mitigation may also include following:

- Listen to the radio for advance information and advice.

- Disconnect all electrical appliances and move all valuable personal and household goods beyond the reach of floodwater, if one is warned or if one suspects that flood waters may enter the house.
- Move vehicles, farm animals and movables goods to the higher place nearby.
- Keep sources of water pollution i.e. insecticides out of the reach of water.
- Turn off electricity and LPG gas before one has to leave the house.
- Lock all outside doors and windows if one has to leave the house.
- Do not enter floodwaters.
- Never wander around a flood area.

12.5.9 Notifications

Notification procedures are an integral part of any emergency action plan. Separate procedures should be established for slowly and rapidly developing situations and failure. Notifications would include communication of either an alert situation or an alert situation followed by a warning situation. An alert situation would indicate that although failure or flooding is not imminent, a more serious situation could occur unless conditions improve. A warning situation would indicate that flooding is imminent as a result of an impending failure of the dam. It would normally include an order for evacuation of delineated inundation areas.

12.5.10 Notification Procedures

Copies of the EAP that also include the above described inundation map are displayed at prominent locations, in the rooms and locations of the personnel named in the notification chart. For a regular watch on the flood level situation, it is necessary that the flood cells be manned by two or more people so that an alternative person is always available for notification round the clock. For speedy and unhindered communication, a wireless system is a preferable mode of communication. Telephones may be kept for back up, wherever available. It is also preferred that the entire flood cells, if more that one, are tuned in the same wireless channel. It will ensure communication from the dam site to the control rooms. The communication can be established by messenger service in the absence of such modes of communication.

12.5.11 Management after receding of Flood Water

It is to be accepted that in the even of dam break, even with maximum efforts, the loss of human lives, livestock and property would be inevitable. Under such a scenario, a massive effort would be used by various government agencies to provide various relief measures to the evacuees. Formulation of a plan delineating such measures is beyond the scope of work of this document. However, some of the measures which need to be implemented are listed as below:

- Provision of various food items and shelter to the evacuees.
- Provision of fuel for various evacuees.
- Provision of adequate fodder supply.
- Arrangements for potable water supply.
- Commissioning of low cost sewage treatment and sanitation facilities, and disposal of treatment sewage.
- Expeditious disposal of dead bodies human and livestock.
- Immunization programmes for prevention of outbreak of epidemics of various water related diseases.
- Adequate stocks of medicines of various diseases, especially water-related diseases.

12.6 EMERGENCY RESPONSE ORGANISATION

The KBJNL will be the Chief Emergency Organization (CEO). The Managing Director, KBJNL will be Chief Emergency Co-ordinator (CEC), who will be overall in the charge of planning, execution and co-ordination of all activities of Disaster Management Plan. An alternative member, in his absence, will also be notified for co-ordinating the emergency response activities. The CEC will report and co-ordinate all activities through Deputy Commissioners. He will carry out all the functions necessary to co-ordinate the relief measures and forms a focal point between field and State level administration.

The CEC is to be assisted by ail Emergency Planning Group (EPG) which will be constituted for the purpose of decision making and planning the emergency effort under the plan. The group involves all the heads of departments of water resources, roads, buildings, Transport, Police, Health, Revenue, Rural development, Power transmission and also the heads of Non-Governmental Organisations (NGO) in the local areas.

At taluk level, emergency action groups will be constituted with taluk level officers, such as, Revenue, Health, Taluk. Panchayat, Police, Power transmission officers and other Government and non-Government personnel. The taluk level action group, will pool up and mobilize on the spot available resources and respond immediately to the inundation situations. As many local teams as possible will be constituted. Their main purpose will be to liaise with CEC.

Emergency control centre will be established which will be the focal point in case of an emergency from where the operations to handle the emergency are directed and coordinated. The emergency control centre will be at Bagalkot, being the district headquarters. The centre will be equipped with adequate resources to receive and transmit information and directions from the Chief Emergency Coordinator. Besides equipping the centre, prior necessary arrangements will be made to ensure that the centre would start activating other systems immediately, once the hazard is declared. The centre will contain a well-designed communication system.

For arranging relief in case of any emergency tile Chief Emergency Co-ordinator, (MD, KBJNL,) Almatti will be tile Nodal Officer. Every year during the month of June, and as and when flood situation warrants a meeting will be conducted with the heads or districts and review or the arrangements will be taken. This being difficult and major task, the co-operation of all the district officers will be taken for proper management and smooth working.

The following functions are delineated for the Chief Emergency Coordinator. He will take various emergency decisions by convening the immediate meeting/ conferencing of Emergency Planning Group. Together, they are responsible for the following:

- Formulation and implementation of the plan

- Guidance/decision on matters of basic policy
- Activation of the emergency control centre and convening the emergency meeting
- Declaring the emergency zones with the help of technical personnel and experts.
- Control on Emergency Operations.
- Review of operational preparedness of emergency machinery
- Holding periodic mock/training exercises to ensure optimum preparedness at operational levels
- Development and updating hazard scenarios and cascading effects from time to time.
- Mobilizing organizations, financial and human resources for the plan.
- Liaison with external/Govt. agencies and assessment of whether any public assistance is required.
- Furnishing information on the incident to District State and National level authorities and if needed competent bodies may be called for assistance.
- Liaison with press/media, to report the emergency.
- Declaring rehabilitation centres in case of evacuation, if called for
- Monitoring post emergency situation in terms of health care, first aid, rehabilitation etc.
- Declare all clear, once everything is normal.

12.7 ACTIONS BEFORE, DURING & AFTER FLOOD

12.7.1 Pre-flood arrangements

- Convening a meeting of the District Level Committee on Natural Calamities;
- Functioning of the Control Rooms;
- Closure of past breaches in river and canal embankment and guarding of week points;
- Rain-recording and submission of rainfall reports
- Communication of gauge-readings and preparation of maps and charts;

- Assigning charge of flood Circles;
- Dissemination of weather reports and flood bulletins issued by the meteorological Centres, Central Water Commission, Flood Forecasting Organisation;
- Deployment of boats at strategic points;
- Use of power boats;
- Installation of temporary Police Wireless Stations and temporary, telephones in flood-prone areas
- Arrangement for keeping telephone and telegraph lines in order
- Storage of food in interior, vulnerable strategic and key areas:
- Arrangements of dry food stuff and other necessities and of lire;
- Arrangements for keeping the drainage system desilted and properly maintained,
- Agricultural measures;
- Health measures;
- Veterinary measures;
- Selection of flood shelters:
- Advance arrangements for army assistance;
- Training in flood relief work;
- Organisation of relief parties;
- Other precautionary measures; and
- Alternative drinking water supply arrangements;

12.7.2 Arrangements During and After Floods

- Organising rescue operations
- Organising shelter for the people in distress, in case the efforts of the Civil authorities are considered inadequate, Army assistance should be requisitioned,
- Relief measures by non-official and voluntary organisations may be enlisted as far as possible, .

- Organise relief camps.
- Provision of basic amenities like drinking water, sanitation and public health care and arrangements of cooked food in the relief camps
- Taking necessary arrangements for air dropping of food packers in the marooned villages through helicopters.
- Organising enough relief parties to the rescue of the marooned people within a reasonable time limit.
- Establish alternate communication links to have effective communication with marooned areas.
- Organising controlled kitchens to supply foods initially at least 3 days.
- Organising cattle camps, if necessary, and provide veterinary care, fodder and cattle feed to the affected animals.
- Grant of emergency relief to all the affected people.
- Submission or daily reports and disseminate correct information through mass media to avoid rumors.
- Rehabilitation of homeless.
- Commencement of agricultural activities-desiltation, resowing.
- Repairs and reconstructions of infrastructural facilities such as roads, embankments, Resettlement of flood prone areas.
- Health measures.
- Relief for economic reconstruction

12.8 EMERGENCY CONTROL CENTRE

An emergency control centre shall be opened which shall comprise of the following:

- At least two external telephones (one incoming and the other one out going fitted with simultaneous/selective broadcasting systems).
- Wireless/Radio equipment (VHF/mobile)
- Inundation/vulnerability maps indicating risk zones, assembly points, alternate evacuation routes, safe areas, rehabilitation centres, etc.
- Telephone directory of emergency response system

- List of all emergency equipment and personnel for evacuation. personnel protection, medical aid, etc., under the plan as well as with Government agencies in the district
- List of ambulances, base medical facilities, hospitals, rehabilitation centres, etc
- Reference books/chemical dossiers
- Copies of Disaster Management Plan.

An Emergency Group will be formed, which will carry out frontline activities at the time of disaster. Preferably as many local teams as possible be formulated for the purpose. The main activities or EAG are:

- Rush to the emergency zone
- Make systematic assessment of hazard
- Liaise with Chief Emergency Coordinator
- Carryout evacuation, if necessary
- Carryout emergency actions
- Extend relief, first aid, human assistance
- Organise rehabilitation centres

12.9 COST ESTIMATES

The budget for different activities required to be carried out for mitigation and prevention of dam break hazard exclusively from the dam is Rs 1230.00 lakh as per details given in Table-12.2.

Table-12.2: Budget earmarked for implementation of Disaster Management Plan

S. No.	Particular	Cost (Rs. lakh)
1.	Installation of alert system in control room	100.0
2	Setting up of communication between various projects on river Mahakali/Sharda	200.0
3	Setting up of communication system between dam and d/s settlements	300.0
4	Public information system	200.0
5	Setting up of a seismic observatory at dam site	400.0
6	Training and miscellaneous expenses	30.0
	Total	**1230.0**